おっ！と驚く、セラミックス。

Surprising Ceramics.

日本ガイシ NGK

EnerCera エナセラ®

New solution for maintenance free IoT devices by semi-solid state Li-ion rechargeable EnerCera® batteries

NGK Europe GmbH / NGK INSULATORS, LTD.

Dr. Makoto Iwai

November 16th 2022,
München, Electronica

Self-introduction

Dr. Makoto Iwai

Germany

Manager at NGK Europe GmbH

Biography

Makoto Iwai is a manager, responsible for development DS related new business. Makoto joined NGK INSULATORS in 1997 as an research engineer of Corp. R&D, developed optical components, wide band gap semiconductor wafers, etc. and he belonged Future technology management center, Corp. R&D from 2016 to 2021. He started work at NGK Europe, Germany in 2021. He holds a doctor degree in Electrical Engineering from Osaka University, Japan.

https://electronica.de/application/en/program/forums/speaker/makoto-iwai-160880

Today's Outline

- **About NGK**
  - ・Corporate Profile
- **Maintenance free IoT devices**
  - ・Problem of power supply for IoT devices
  - ・Features of EnerCera® Batteries
  - ・Introduction of initiatives for social implementation
    - ・Combination with WPT* *Wireless Power Transfer
    - ・Combination with Energy harvester
- **Closing**

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Outline of NGK

Company Name	**NGK INSULATORS, LTD.**
Date of Establishment	**May 5, 1919**
Paid-in Capital	**69,849 Million Yen**
Representative Directors	Chairman **Taku Oshima**
	President **Shigeru Kobayashi**
	Executive Vice President **Chiaki Niwa** **Ryohei Iwasaki**

Number of Employees (consolidated)	**20,099**	※Outside Japan employees **63%** As of March, 2022
Consolidated Subsidiaries	**45 companies**	※Outside Japan Subsidiaries **30** As of March, 2022

The Origin of NGK

1876 森村商事株式会社 MORIMURA BROS., INC. Porcelain Export

1904 Noritake China ware

1917 TOTO Sanitary ware

1919 NGK INSULATORS

1936 NGK SPARK PLUGS NTK TECHNICAL CERAMICS NGK SPARK PLUG CO., LTD. Spark plug

NGK Group Philosophy

Our Mission

Enriching Human Life

by Adding New Value to Society.

Our Values

Quality of People　Embrace challenges and teamwork.

Quality of Product　Exceed expectations.

Quality of Management　Social trust is our foundation.

New Value to be Provided by NGK

CO_2 separation membranes

Under harsh usage,
realizing high-precision separation
and capture of CO2

Zinc rechargeable batteries

As there is no risk of fire accidents,
they can be installed indoors and
safely realize emergency power supply
and renewable energy utilization

Future products

SOEC (Solid oxide electrolyzer cells)

We will use ion-conducting ceramics to create fuels and raw materials from CO_2 and water with high efficiency

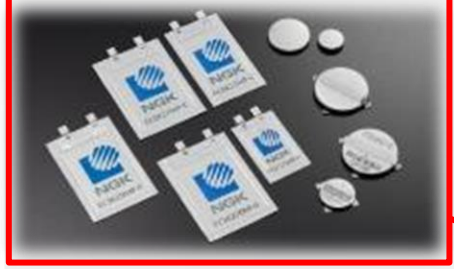
Honeycomb structural reactors for synfuel

We will utilize large-scale extrusion and separation membrane technologies to make fuel and raw-material synthesis more efficient

Carbon Neutrality

EnerCera ®

Realizing a maintenance-free IoT
More secure smart cards
Wearable devices closer to our life



Wafers

Contribution to 5G and next-generation telecommunications networks with high speed and high data capacity

Future products

Sensors for mobility

Our high-precision package technology will contribute to the realization of autonomous driving, such as the evolution of LiDAR

New bonded wafers (for sensing devices and next-generation telecommunications networks)

Contributing to autonomous driving sensors and ultra-high-speed communication by utilizing ultra-thin polishing and multi-materials bonding technologies

Digital Society

Today's main topic

Ceramic Technologies
Materials・Processes・mass-production technology

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Future society contributed by IoT devices

https://www8.cao.go.jp/cstp/english/society5_0/index.html

Every IoT device works autonomously,
We are unconscious about IoT device in our Society

Issue of IoT devices

Smartphone is very convenient, Smart watch is useful, but Smart home, building, logistics, factory, etc. are not widely adopted yet…

Autonomously work IoT devices that support Social Infrastructures are not realized yet.

Why?

https://www8.cao.go.jp/cstp/english/society5_0/index.html

Because of the issue of power source of IoT devices

Requirement for ideal autonomous IoT device power supply

Required function for maintenance free IoT devices

			Required function for storage device
Storage	Compatibility with WPT or Energy Harvest	Store tiny power	Low internal resistance
		Stored power can be retained	Small self discharge
		No need to control current	Constant Voltage charge
		Continuously charge	Tough under full charged state
Discharge	Sensing, Processing, wireless communication	Long lifetime	Long cycle time
		LTE, Edge AI compatible	Large discharge current
		Stable operation	Stable voltage
Installation	Can be installed anywhere	Wearable	No generate heat or ignite
		Can be retrofitted in tight spaces	Small and thin
		Can be used in harsh environments	Wide operation temperature range

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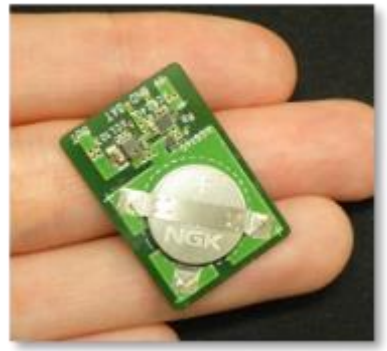
What is EnerCera Battery ?

EnerCera battery has unique characteristics of both Lithium-ion rechargeable battery and capacitor

EnerCera battery series is a semi-solid-state* rechargeable battery which incorporates NGK's proprietary crystal-oriented ceramic electrodes.

※A solid, multi-layered structure incorporating a crystal-oriented cathode active material sintered which infused with a small amount of liquid electrolyte

EnerCera Pouch



EnerCera Coin

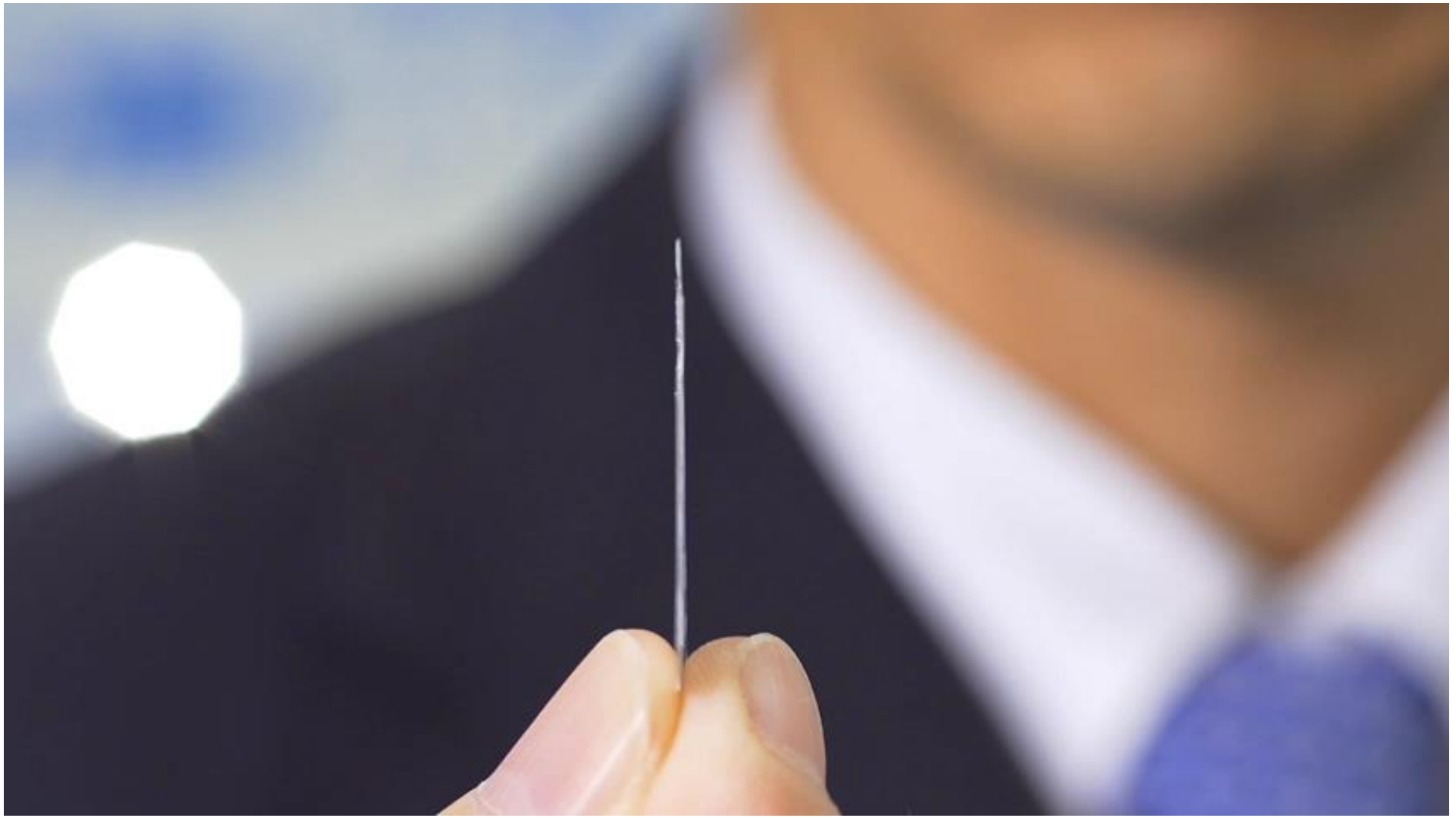
Application: Card type devices, RFID Tags
Wearable devices, ESL, etc.

Features: Ultra-thin (0.45㎜), Bending resistance,
High-speed charging

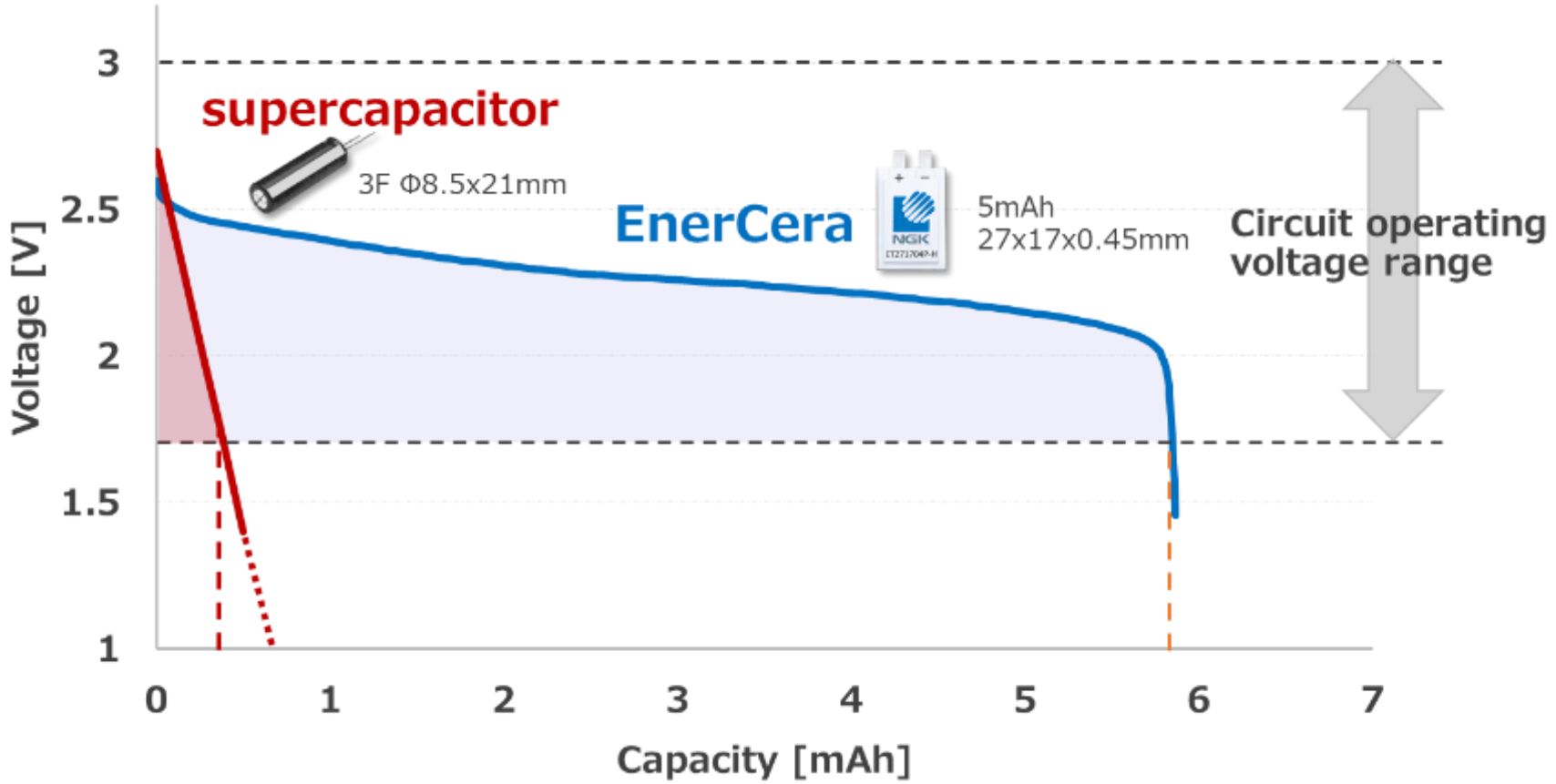
Application: Small sensor devices, industrial equipment
/in-vehicle products, backup power supplies, etc.

Features: High heat resistance (~ 105 ℃),
reflow solder mounting, constant voltage

What is EnerCera Battery?



Comparison with EnerCera and capacitor



EnerCera can

- ✓ output much higher energy at stable voltage between circuit operating voltage 1.8～3.0V than capacitor.
- ✓ output high current suitable for wireless communication of BLE etc. due to the low internal resistance compared to other small batteries(primary, rechargeable).

⇒ **EnerCera can output high current such as capacitor and is a new storage device that is able to discharge at stable voltage, not capacitor.**

※This material is for reference only and is not guaranteed by the Company.

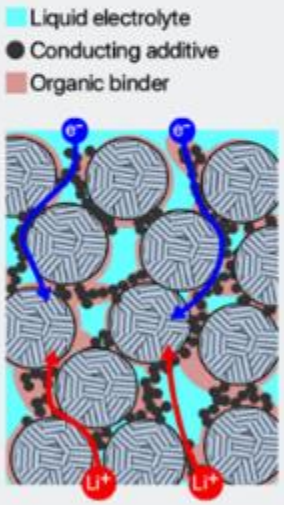
EnerCera's key technologies

Conventional Lithium-ion Batteries

Coated-Powder Electrode

Electrode active material is bound with conducting additives and organic binders.

At high temperatures, the organic binder reacts with the liquid electrolyte causing a reduction in binding strength.



Features

- Low energy density
- High electrical resistance
- Low thermal resistance

NGK EnerCera Coin

Proprietary Crystal-Oriented Ceramic Electrode

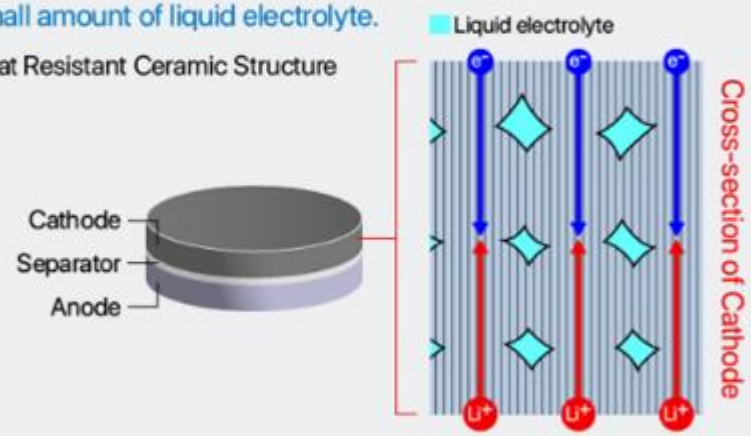
Cathode active material comprises crystal-oriented sintered ceramic.

- Lithium-ions and electrons travel rapidly through active material
- No organic binders or conducting additives

Proprietary Semi Solid-State Battery Technology

Multi-layered structures incorporates sintered ceramic infused with a small amount of liquid electrolyte.

- Heat Resistant Ceramic Structure

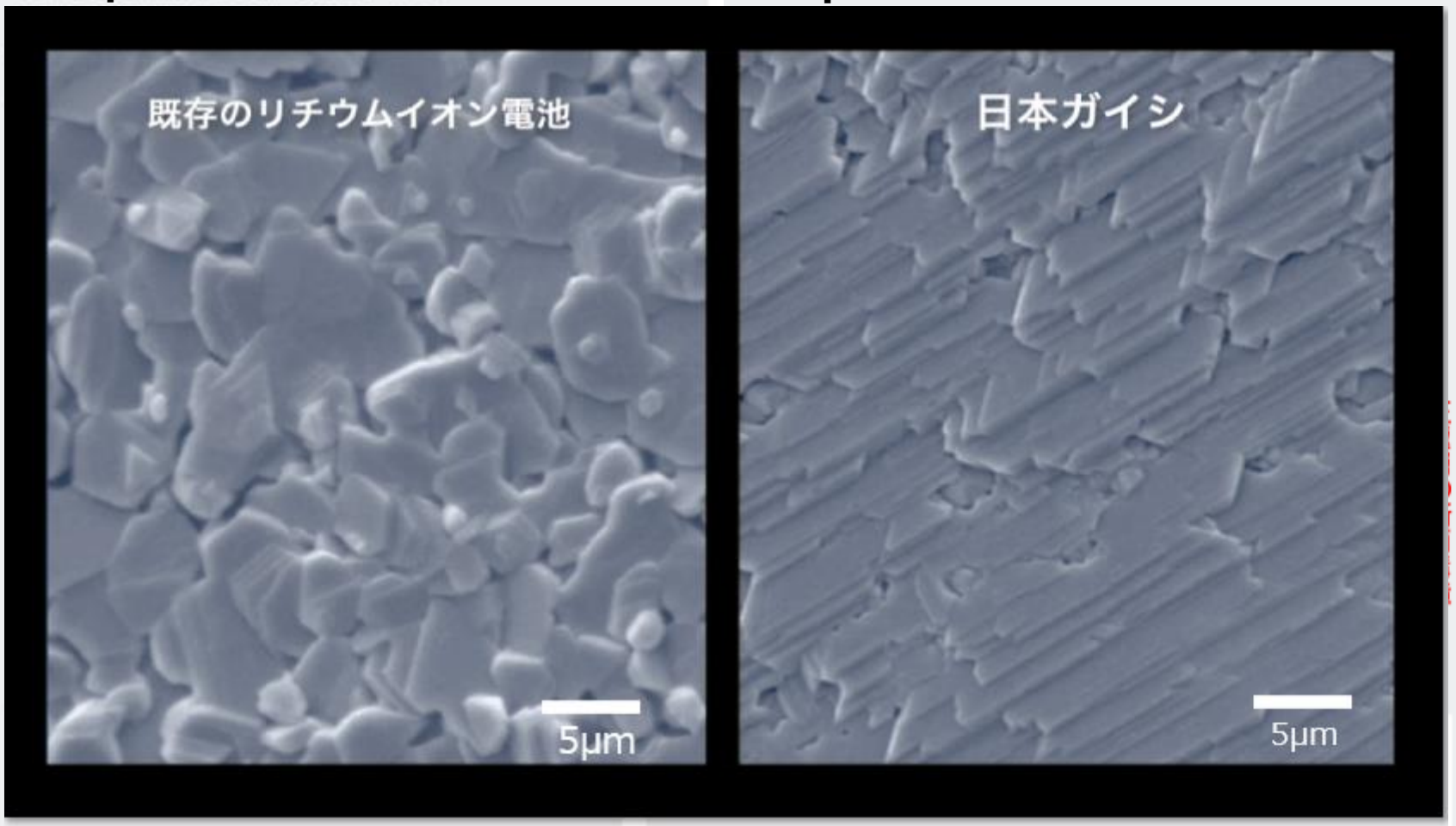


Features

- High energy density
- Low electrical resistance
- High thermal resistance
- Long life expectancy

Key Technology of EnerCera

Conventional Li-ion battery	EnerCera battery
Coated-powder positive electrode	Crystal-oriented ceramic positive electrode



Electron microscope image of positive electrode

EnerCera Lineup

Model Number	EC382704P-T (New number under development)	EC382504P-P	EC382704P-C	EC382204P-C	EC302304P-C	EC382704P-H	ET271704P-H
Appearance							
Dimensions	38 x 27mm	38 x 25mm	38 x 27mm	38 x 22mm	30 x 23mm	38 x 27mm	27 x 17mm
Thickness	0.45mm						
Nominal Capacity (Charging Voltage)	27mAh (4.3V) 24mAh (4.2V)	20mAh (4.2V)	27mAh (4.3V) 24mAh (4.2V)	20mAh (4.3V) 18mAh (4.2V)	15mAh (4.3V) 14mAh (4.2V)	20mAh (4.2V)	5mAh (2.7V)
Nominal Voltage	3.8V						2.3V
Charging Condition	Constant current (CC) - Constant Voltage (CV) charging						CV charging
(Ref.) Peak Discharge Current*1	560mA	500mA	260mA	200mA	130mA	130mA	100mA
Bendability	Conforming to ISO 14443-1 standard No deterioration after bending and torsion tests						
Operation Temp.	Discharge : -20℃ ~ 45℃ (Charge : 0℃~45℃)					Discharge : 20℃~60℃ (Charge : 0℃ ~ 60℃)	-40 ~ 70℃
Heatproof Temp. (in process)	80℃					135℃	
Features	High Power		High capacity			High heat resistance	Fast charging*2

*1 Voltage drop is less than 0.5V with continuous discharge for 0.1 sec. (at 25℃)
*2 Can be charged from 0% to 80% capacity in 14min.

IEC62133 certified
Contents may be changed without notice.

Model Number	ET2016C-R	ET1210C-H	ET2016C-H
Appearance			
Size	Φ20 x 1.6mm	Φ12.5 x 1.0mm	Φ20 x 1.6mm
Nominal Capacity (2.7V charge)	25mAh	4mAh	20mAh
Nominal Voltage	2.3V		
Charging Condition	Constant Voltage (CV) charging (No current control required)		
(Ref.) Peak Discharge Current*1	60mA	20mA	45mA
Operation Temp.	-40℃ ~ 60℃	-20℃*2 ~ 105℃	125°C type Under development
Implementation specifications	Reflow soldering applicable*3		

*1 Voltage drop is less than 0.5V with continuous discharge for 0.1 sec. (at 25℃)
*2 -40°C to 105°C for RTC backup applications.
*3 Please check with us for the conditions.

IEC62133 certified
Contents may be changed without notice.

We have a wide lineup of EnerCera Pouches and Coins such as high-power type, high-capacity type and heat-resistant type.

Requirement for ideal autonomous IoT device power supply

EnerCera is the best power storage device for IoT !

EnerCera エナセラ®

Required function for storage device

- Low internal resistance
- Small self discharge
- Constant Voltage charge
- Tough under full charged state
- Long cycle time
- Large discharge current
- Stable voltage
- No generate heat or ignite
- Small and thin
- Wide operation temperature range

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    - ・Combination with WPT
    - ・Combination with Energy harvester
- Closing

Introduction of initiatives for social implementation

Battery for IoT to realize “maintenance-free”

Introduction of initiatives related to power generation and power supply

Storage small power continuously

Discharge large power when necessary

Drive IoT Sensors, MCU, BLE, Wi-Fi, LoRa, etc.

Wireless power supply

Energy Harvest
Light, Heat, Vibration, etc.

EnerCera エナセラ®

With a wireless and long-life system contribute to DX and SDGs

DX: Digital Transformation, SDGs: Sustainable Development Goals

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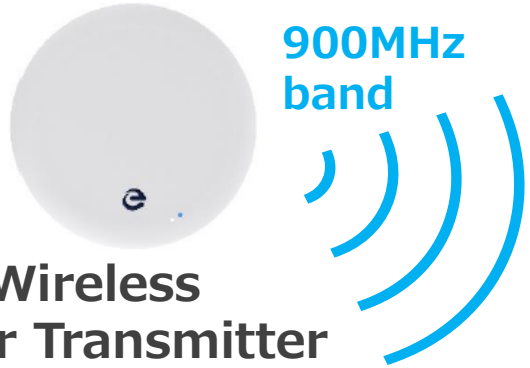
Solution by WPT and EnerCera ①

Wireless Power Transfer

NGK started collaboration with Energous, USA



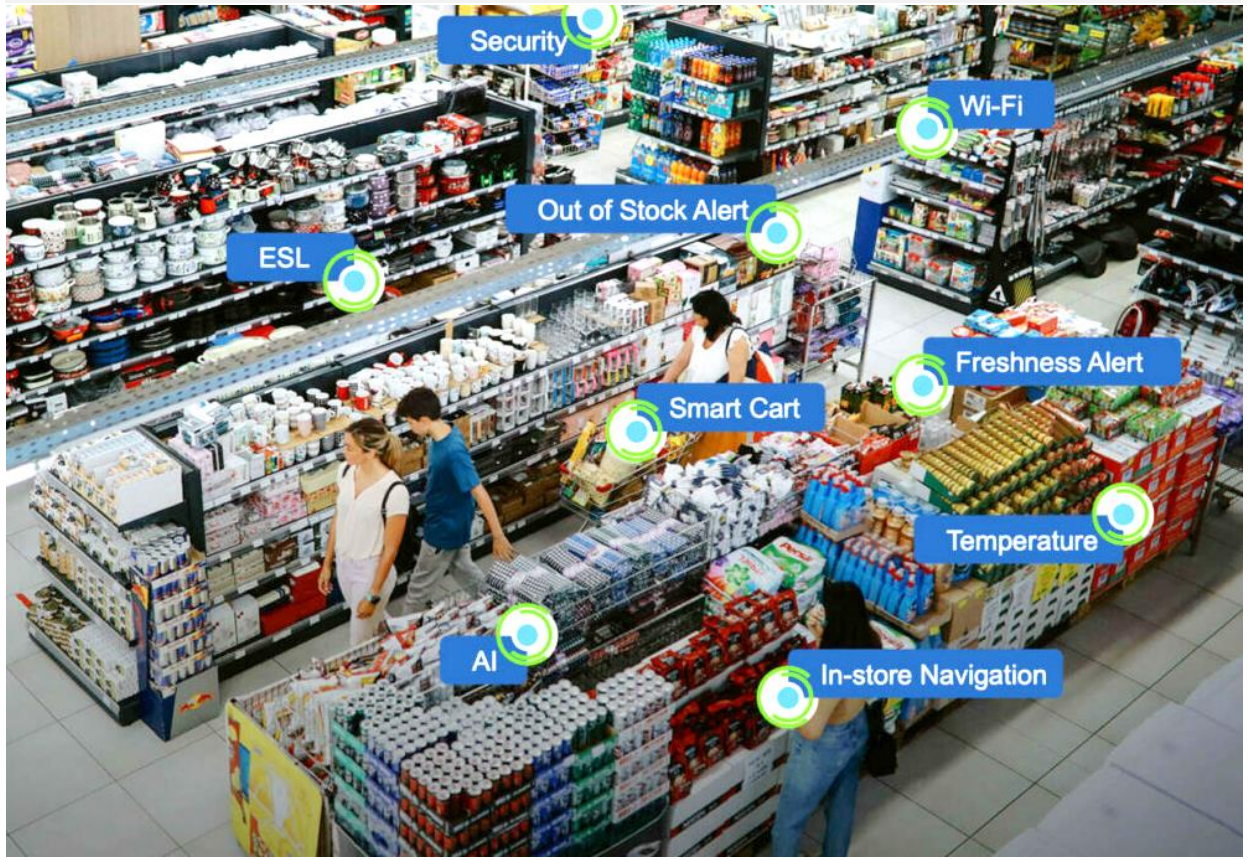
Wireless Power Transmitter by Energous

EnerCera batteries for power supply in IoT in devices

NGK

EnerCera® Pouch

IoT&Retail



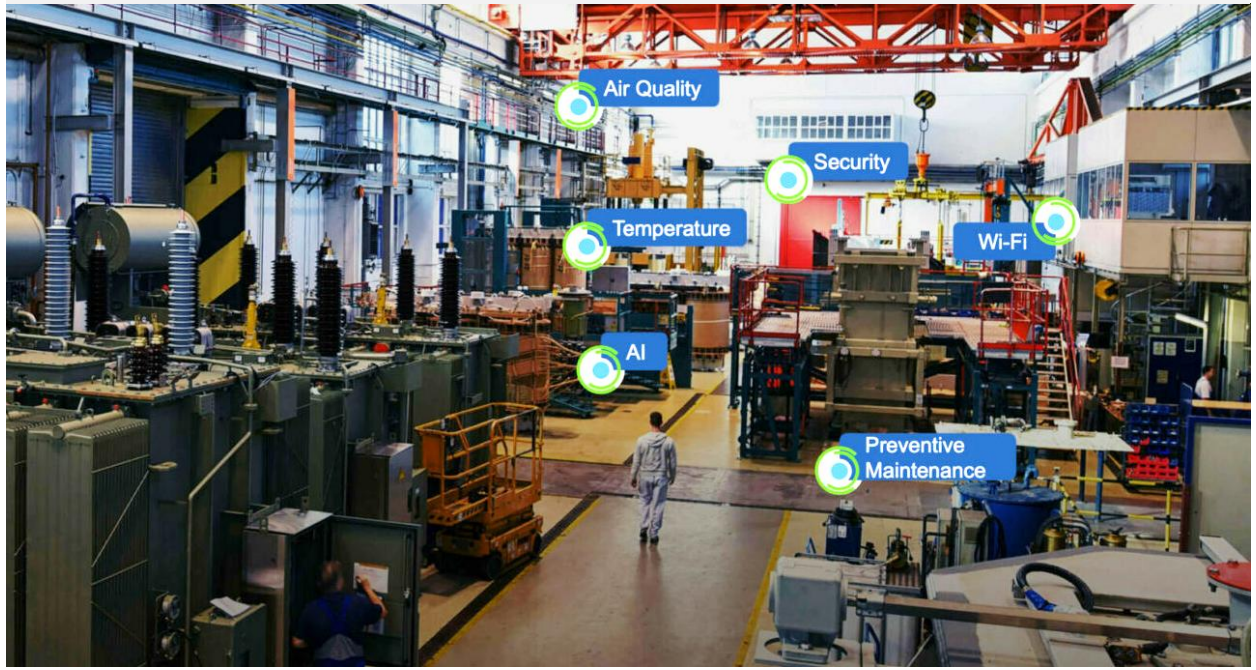
https://energous.com/markets-applications/iot-and-retail/

Expand to various IoT sensor devices, asset tracker, electric shelf label(ESL), etc. !
Aiming for a wireless and smart society with a strong tag with Energous.

Application image of WPT and EnerCera

Wireless **P**ower **T**ransfer

Industrial IoT



https://energous.com/markets-applications/industrial-iot/

Health＆Medical

https://energous.com/markets-applications/health-medical/

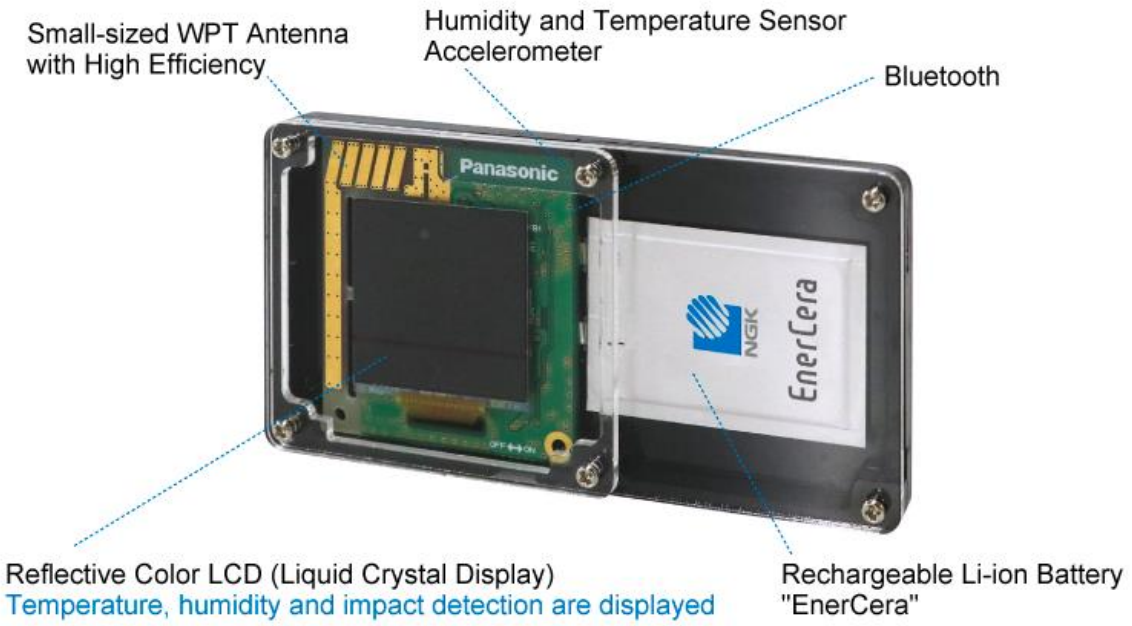
Wireless Energy Harvesting Evaluation Kit from Energous and e-peas

In the Box:

- 1W WattUp PowerBridge Transmitter (1)
- e-peas AEM30940 RF Evaluation Board
- e-peas EP112 Energy Harvesting Optimized Antenna Evaluation Board

Solution by WPT and EnerCera ②

Logistics sensor tag



Developed by Panasonic

Transmitter 920MHz

Wide range power supply system enabled by Wireless Power Transfer(WPT)

Up to 10m

Cargo information are transmitted

Attach the sensor tag to the cargo

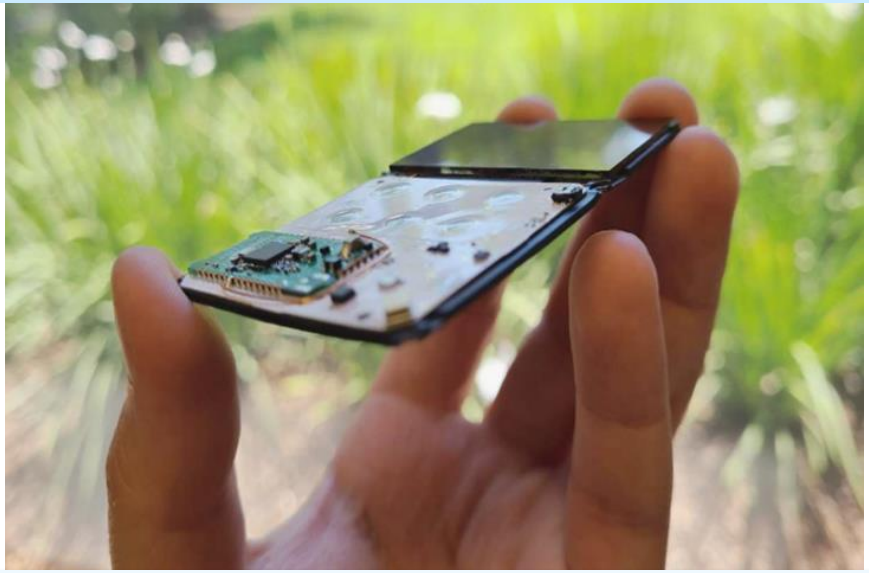
EnerCera® Pouch

Contributes to Smart Logistics IoT in supply chain management.

Solution by WPT and EnerCera ③

Sensor Remote controller for Smart Home

WPT 920MHz band & Solar Cell



- ✓Hybrid power supply
- ✓Designed for smart home IoT
- ✓Safety by semi-solid-state EnerCera batteries

Joint work with SMK

WPT receiver development kit

WPT 5.8GHz band

- ✓Miniaturize receiver size
- ✓Precise WPT power control
- ✓Stable power supply with optimal voltage

Joint work with Torex and Ossia

Today's Outline

- About NGK
  - ・Corporate Profile
- About EnerCera®
  - ・Outline of products
  - ・**Maintenance-free IoT devices**
    - Combination with WPT
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Solution example using PV and EnerCera ①

Solar cell powered card type Tracker

Partner : Tachibana electronic solutions
Exeger Operations
(Contact in Japan: SB Energy)

Product overview

- Stylish appearance（104×72×6㎜）
- Maintenance free by
  EnerCera＋Powerfoyle™
- Position tracking
  by indoor Wi-Fi／ outdoor GPS
- LPWA communication

Application

Asset tracking

Worker visualization
People tracking

Tracking of
Cart at airport,
Shopping mall

Visualization of work time and location information by card-type tracker that does not impair workability

You can get useful information by this tracker for efficiency and labor saving of warehouse work without battery replacement.

Solution example using PV and EnerCera ②

Partner : Exeger Operations AB

Electronic shelf label (ESL) that drive even in low-luminance indoor light

Data

Receive display information by BLE ※

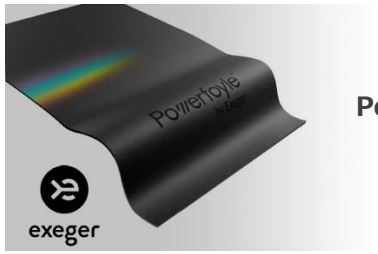
Energy Storage

EnerCera® Coin

Electronic paper display

Switch the display

Power Generation



Electric power

Indoor light
Power GENERATION
PV Cell

Powerfoyle™ by Exeger

- ◆Power generation is possible even in indoor light
- ◆Less affected by light angle of incidence
- ◆Flexibility and superior appearance

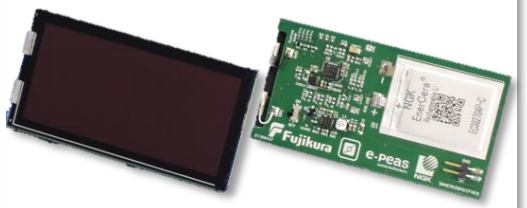
By combining a PV cell that generates power even in low-light indoor light with EnerCera, it eliminates the need to replace batteries in electronic shelf label, which is indispensable for logistics sites.

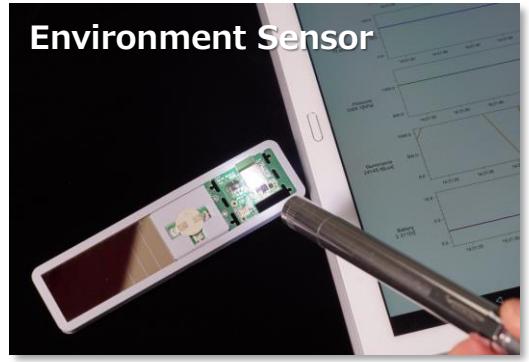
⇒ **Make it "maintenance-free"!**

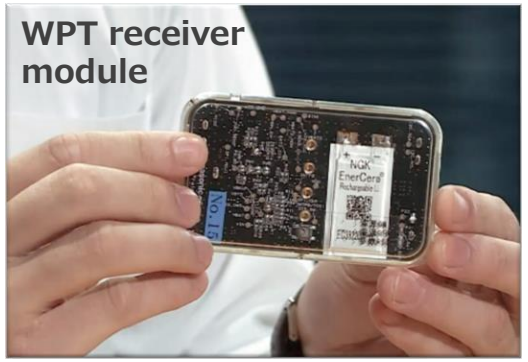
Support system（General Overview）

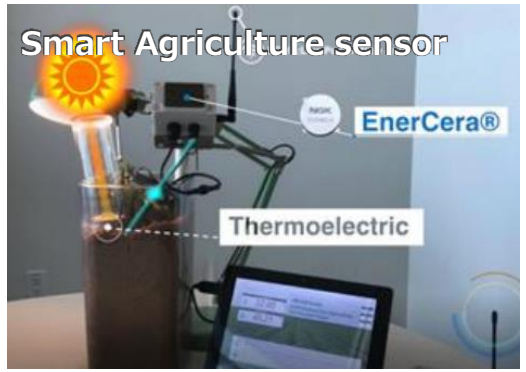
Technology		Partner ※excerpt
Energy Harvest	Solar Cell	EneCoat Technologies
		RICOH
		Exeger/SB Energy
	Vibration	Kanazawa Univ.
	Thermoelectric	E-ThermoGentek
Wireless Power Transfer (WPT)		Toshiba
		Panasonic
		Marubun／Ossia
		Energous
IC & MCU		Renesas Electronics
		Torex Semiconductor
		Nissinbo Micro Devices
		ROHM
		On Semiconductor
		e-peas

Maintenance-free power supply module









Promoting collaboration with partners with power generation and charging technologies to realize autonomous IoT devices.
We together aim to realize a sustainable society by reducing waste.

Support System

To make proposals suitable for your needs, inquiry:

we will support you with our partners.

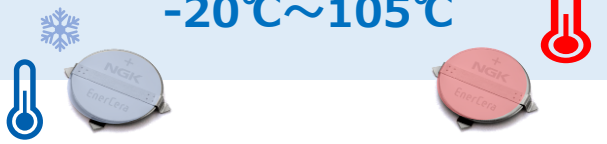
Power generation/charging devices and power supply ICs manufacturers.

EnerCera®

Better future with EnerCera® batteries in Factory Automation

Backup Power solution withstands 105℃, High heat resistance and Reflowable
No deterioration even when fully charged, so you can use for a long time!

	Production	Daily use	Maintenance
Problems of Backup Power	Increase parts & processes required for Backup Power supply	Deteriorate at high temperature Low performance at low temperature	Replacements are necessary periodically
Solution with EnerCera	Reflowable with ICs together!	Operable -20℃～105℃	Long time reliability & reusable and eco-friendly



Applications

- **Backup Power Supply for RTC**

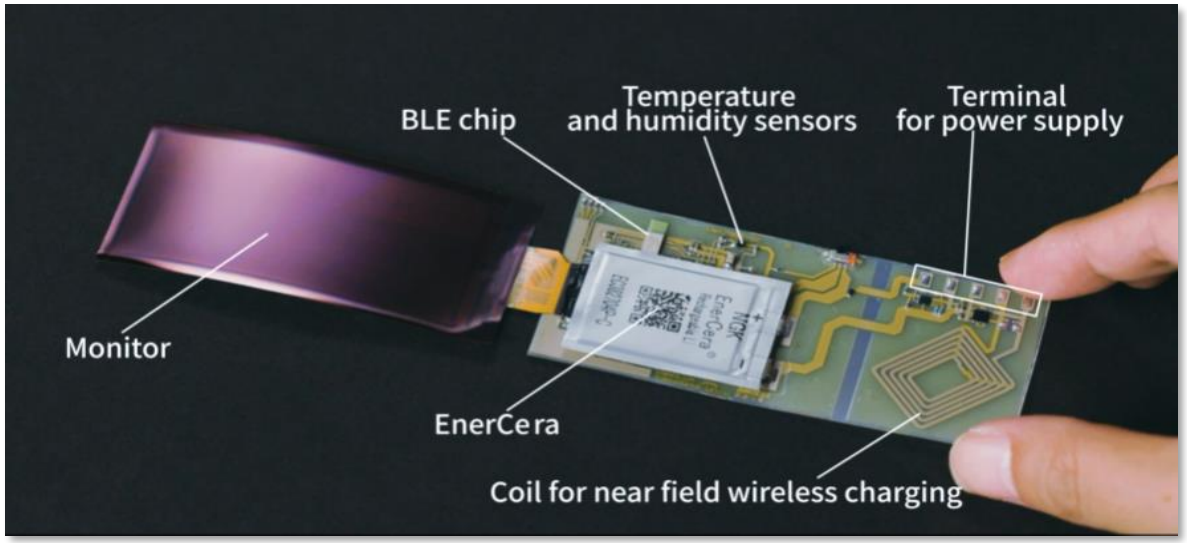
- **Backup Power for Encoders**
- **Backup Power for FA Sensors**

Flexible Logistics Tag using ultra-thin EnerCera Pouch

Partner : Innolux Japan Co., Ltd.

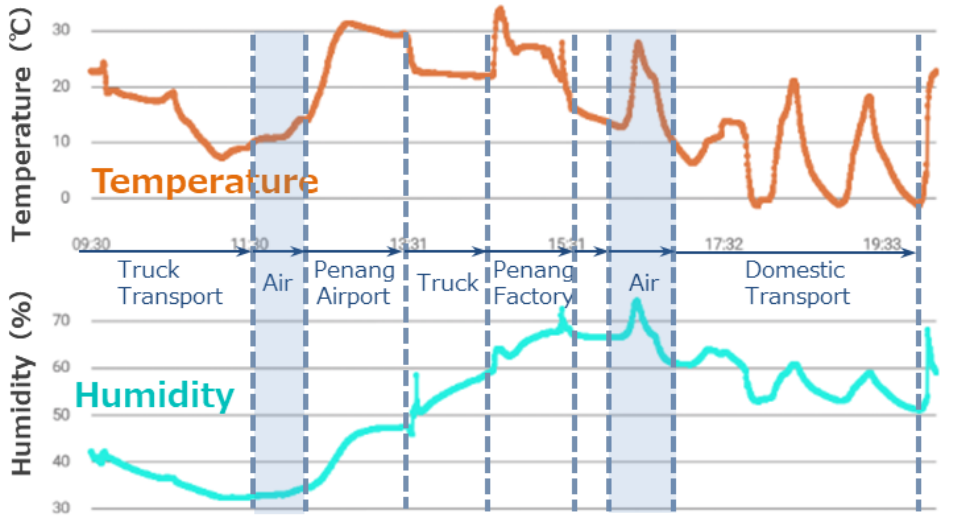
Collaboration of vendable EnerCera Pouch and Flexible Electronics

Communicate to tablet or PC with BLE, and to the cloud through the gateway equipment



- Sensing Information : Temperature, Humidity, Impact
- Operating duration : 5 months on a single charge (depending on measuring cycle)
- It can memorize the maximum & minimum data in the measuring cycle.

Monitoring during transportation between Malaysia and Japan (2/17/2022 ~ 2/28/2022)



Under Development

- ✓ Add Location Information
- ✓ Long-term use by WPT charging

Cold chain compatible ultra-thin tags with flexible circuit board combined with EnerCera enable visualization of cargo transportation status and storage conditions.

Social implementation example

Low power consumption is on track (continuous operation for 5 months)
⇒ Started temperature-controlled transportation test of wine from Italy and Japan (9/19~)

■ Process of transportation from Italy to Japan (9/19~12/M)

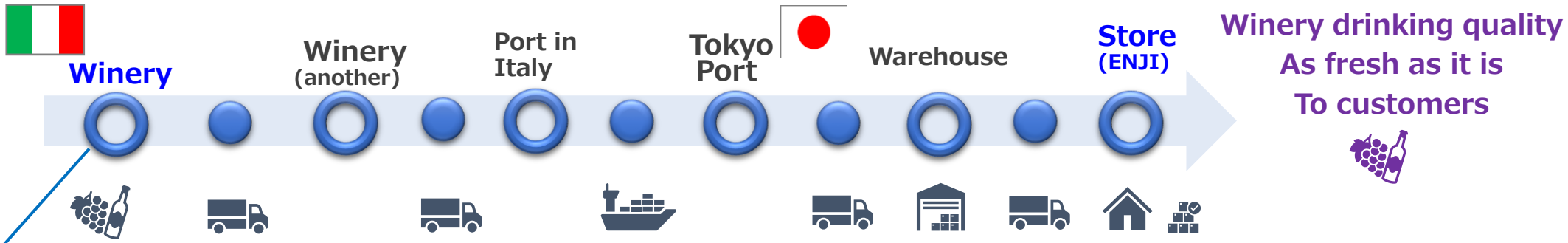


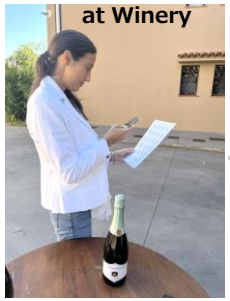
Image of field test

Winery in Italy

‣ Tag attachment, start logging

✓ attached on Bottle and box
✓ Start by Smartphone app

‣ Smart barcode※ tracking below information



✓ QR code
✓ Map
✓ Image
✓ Signiture

Visualization transport status

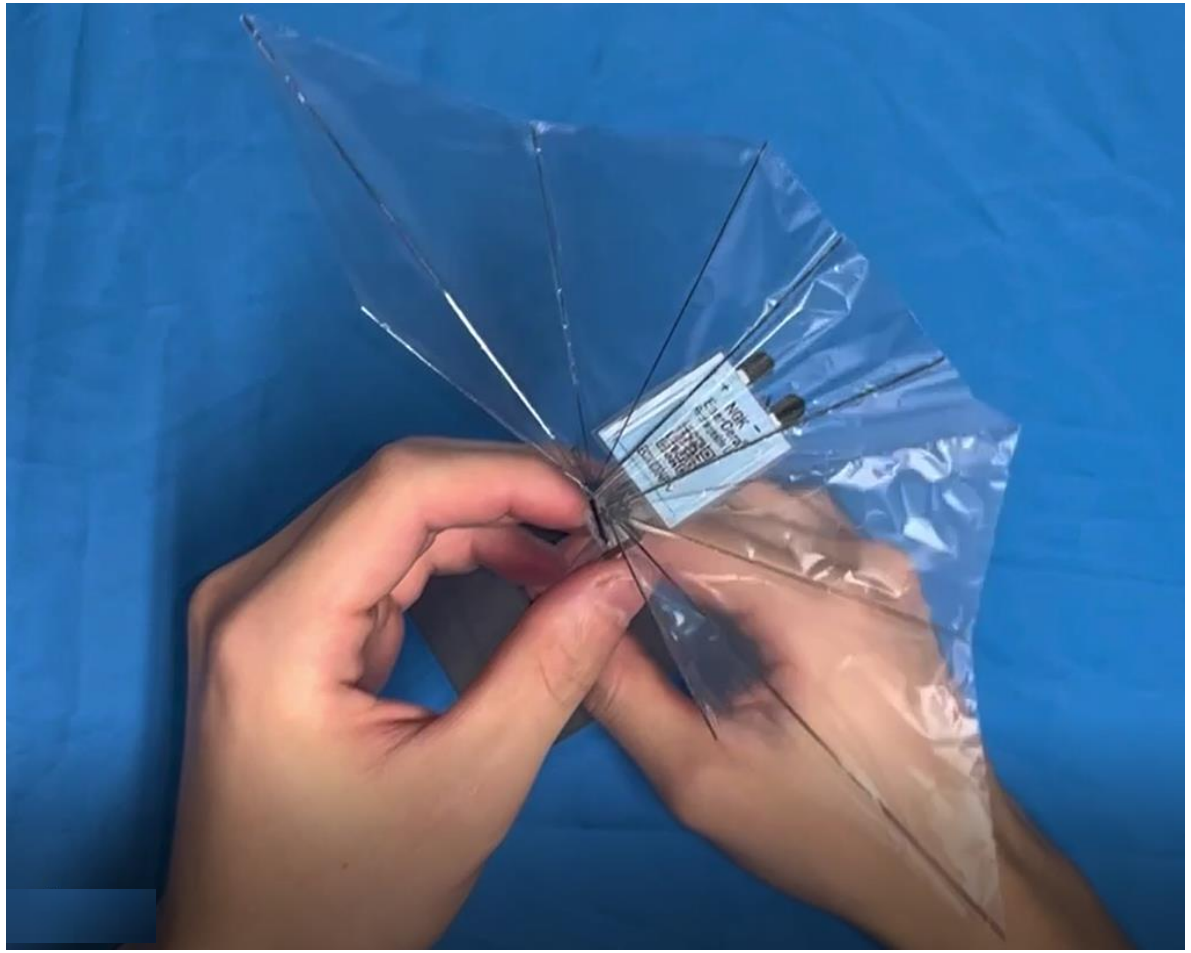
※https://www.lozi.jp/index.html

It can be applied for applications require quality control such as temperature, humidity, and impact during transportation and inventory management.

Butterfly style Flapping Robot

Partner : Tokyo Denki University

Palm size flapping robot by analysis of real butterfly



EnerCera Pouch can drive the motor powerfully.

Today's Outline

- About NGK
  - ・Corporate Profile
- About EnerCera®
  - ・Outline of products
  - ・maintenance-free IoT devices
    - Combination with WPT
    - Combination with Energy harvester
- **Closing**

Future efforts

Contribute to the promotion of Carbon Neutrality and Digital Society

Carbon Neutrality

- **Waste reduction**
  Aiming for the phasing out of primary batteries
  - Circular Economy Action Plan (EU)
  - New batteries Regulations (EU)
- **Utilization of energy harvesting technology**
  Combination with solar cells, vibration power generation, etc.

Digital Society

- **Popularization of IoT**
- **Advances of communication technology**
  5G, 6G communication
- **Higher security**
  Personal information protection

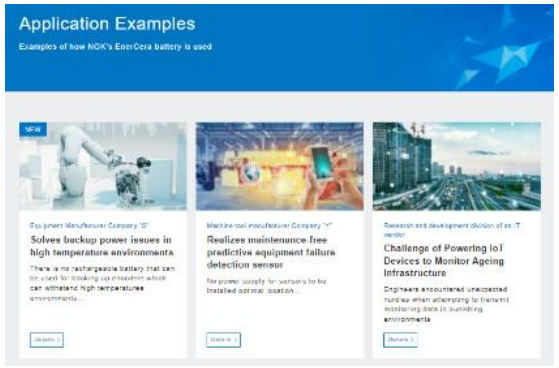
Realization of truly maintenance-free IoT devices

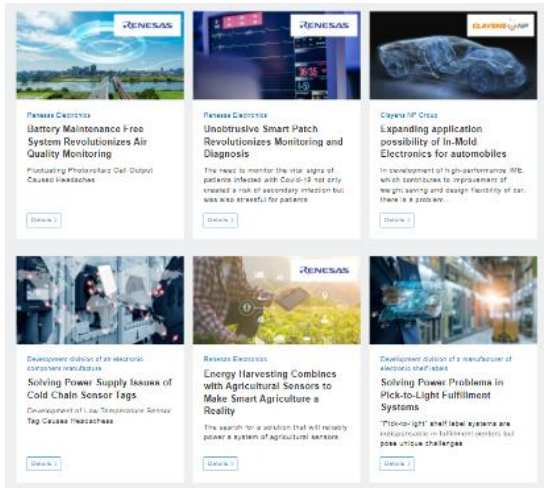
Summary

- ✓ EnerCera is a new power storage device that combines the features of batteries and capacitors.
- ✓ In combination with WPT and Energy Harvester, IoT devices can be made maintenance-free and contribute to the reduction of primary battery waste.

EnerCera Special Site and LinkedIn

Special Site





https://enercera.ngk-insulators.com/en

LinkedIn

概要

NGK Insulators (NGK) is a leading company in the field of ceramics. Since its foundation in 1919, NGK has used its unique ceramic technology to provide numerous ground-breaking products that solve social issues. Today, NGK is active in more than 20 countries worldwide, with business foci including mobility, energy, IT and industry.

As one of the largest manufacturers of ceramic substrates for automotive catalytic converters, NGK is actively reducing the strain on our global environment. Furthermore, NGK's products include the energy storage system "NAS" battery, in addition to the compact, thin and high-energy-density lithium-ion rechargeable "EnerCera" battery line, vital tools for sustainable energy infrastructure.

https://jp.linkedin.com/company/ngk-insulators

Full of useful information such as the features, lineup, and application examples of EnerCera

Welcome to NGK's booth (B3-430)

We are waiting for your visit!

Please feel free to contact us for demonstrations using EnerCera or inquiries about EnerCera

Thank you

Contact

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